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Tan et al.

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(54) **MOLDED SEMICONDUCTOR PACKAGE
WITH PLUGGABLE LEAD**

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(58) **Field of Classification Search**

CPC *H01L 23/28*; *H01L 23/31*; *H01L 23/32*; *H01L 23/48*; *H01L 23/04*; *H01L 23/057*; *H01L 23/10*

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USPC 257/678, 690, 698, 707, 730, 773, 786, 257/787, E23.007, E23.01, E23.023, 257/E23.024, E23.07, E23.078

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See application file for complete search history.

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(57)

ABSTRACT

A semiconductor package includes a semiconductor die having a plurality of terminals, a molding compound encapsulating the semiconductor die, and a pluggable lead dimensioned for insertion into an external receptacle. The pluggable lead protrudes from the molding compound and provides a separate electrical pathway for more than one terminal of the semiconductor die. The separate electrical pathways of the pluggable lead can be provided by electrical conductors isolated from one another by electrical insulator such as molding compound or other insulation material/medium.

15 Claims, 12 Drawing Sheets

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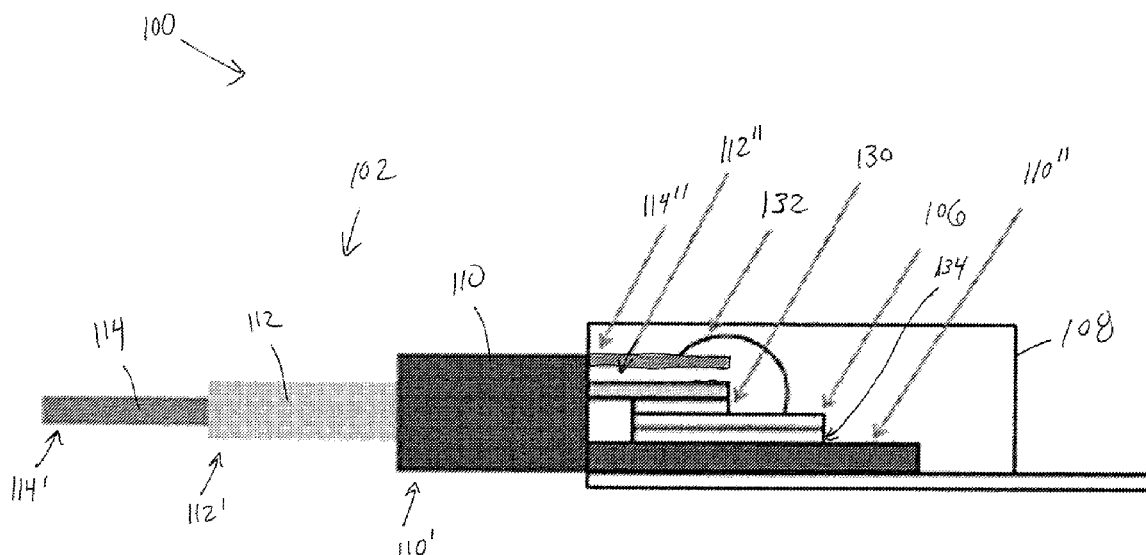
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(51) **Int. Cl.**

<i>H01L 23/32</i>	(2006.01)
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<i>H01L 23/00</i>	(2006.01)
<i>H01L 23/16</i>	(2006.01)
<i>H01L 23/31</i>	(2006.01)

(52) **U.S. Cl.**

CPC *H01L 23/32* (2013.01); *H01L 23/057* (2013.01); *H01L 23/16* (2013.01); *H01L 23/28* (2013.01); *H01L 23/3107* (2013.01); *H01L 23/48* (2013.01); *H01L 24/42* (2013.01); *H01L 2224/48091* (2013.01); *H01L 2224/73265*



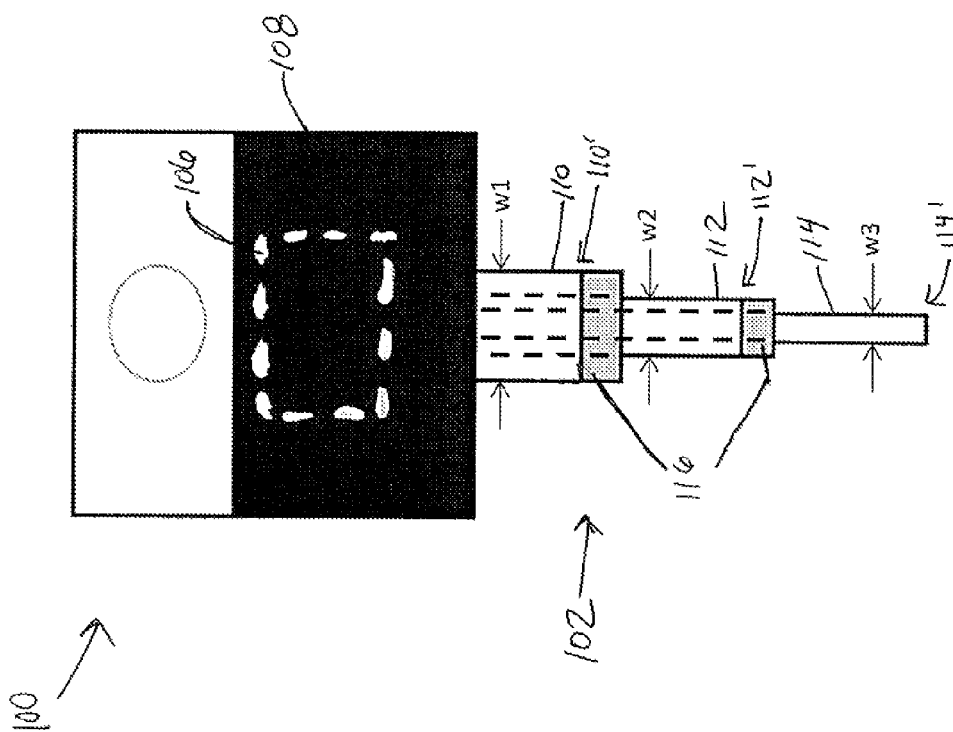


Figure 1A

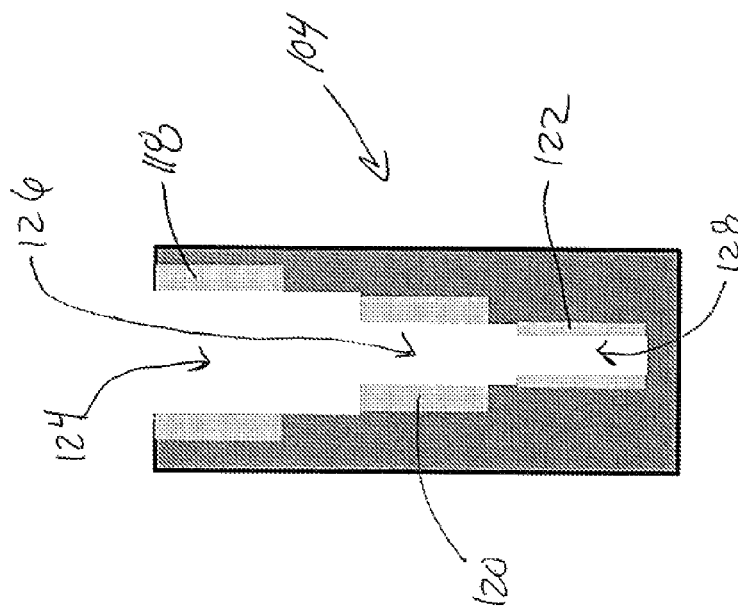


Figure 1B

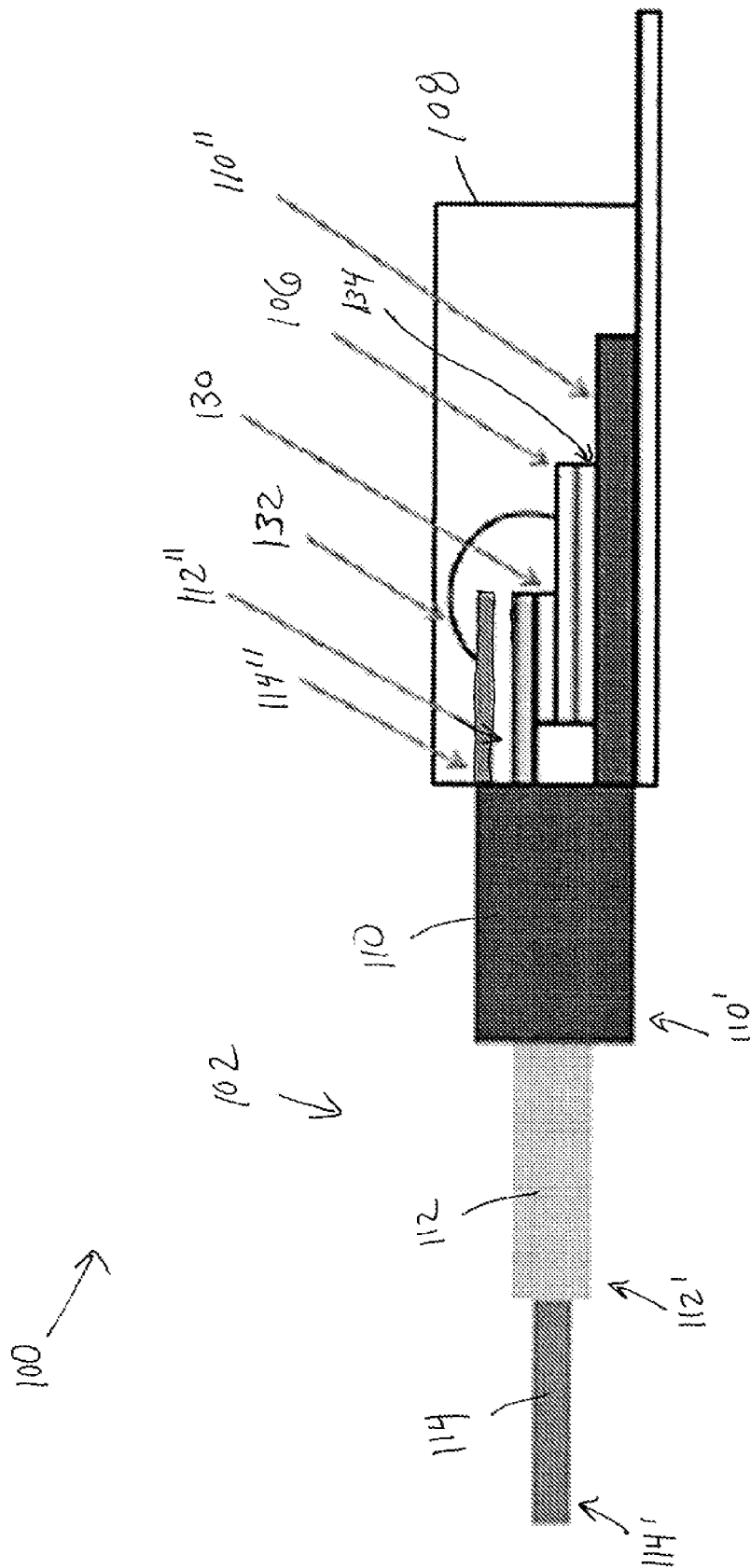


Figure 2

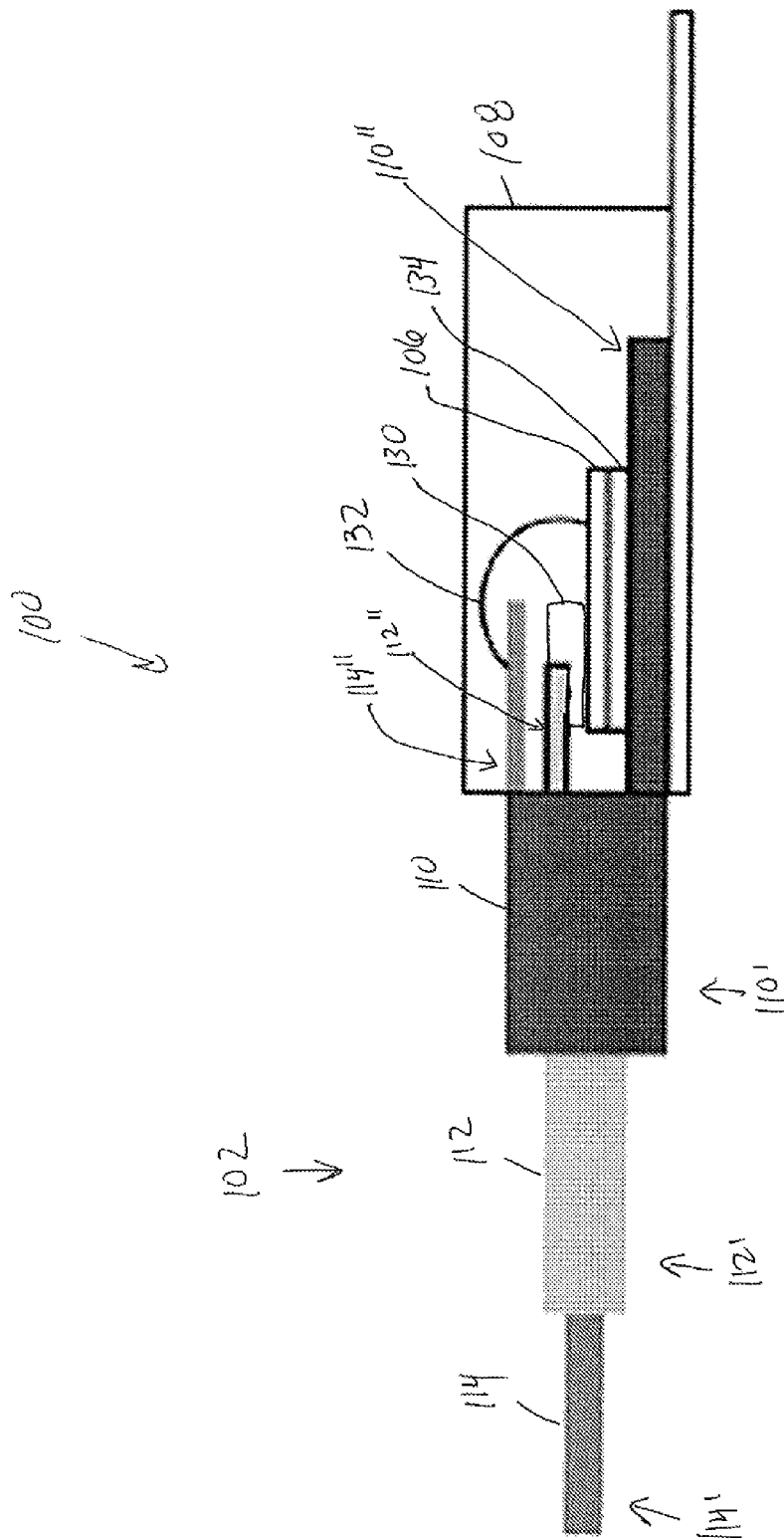


Figure 3

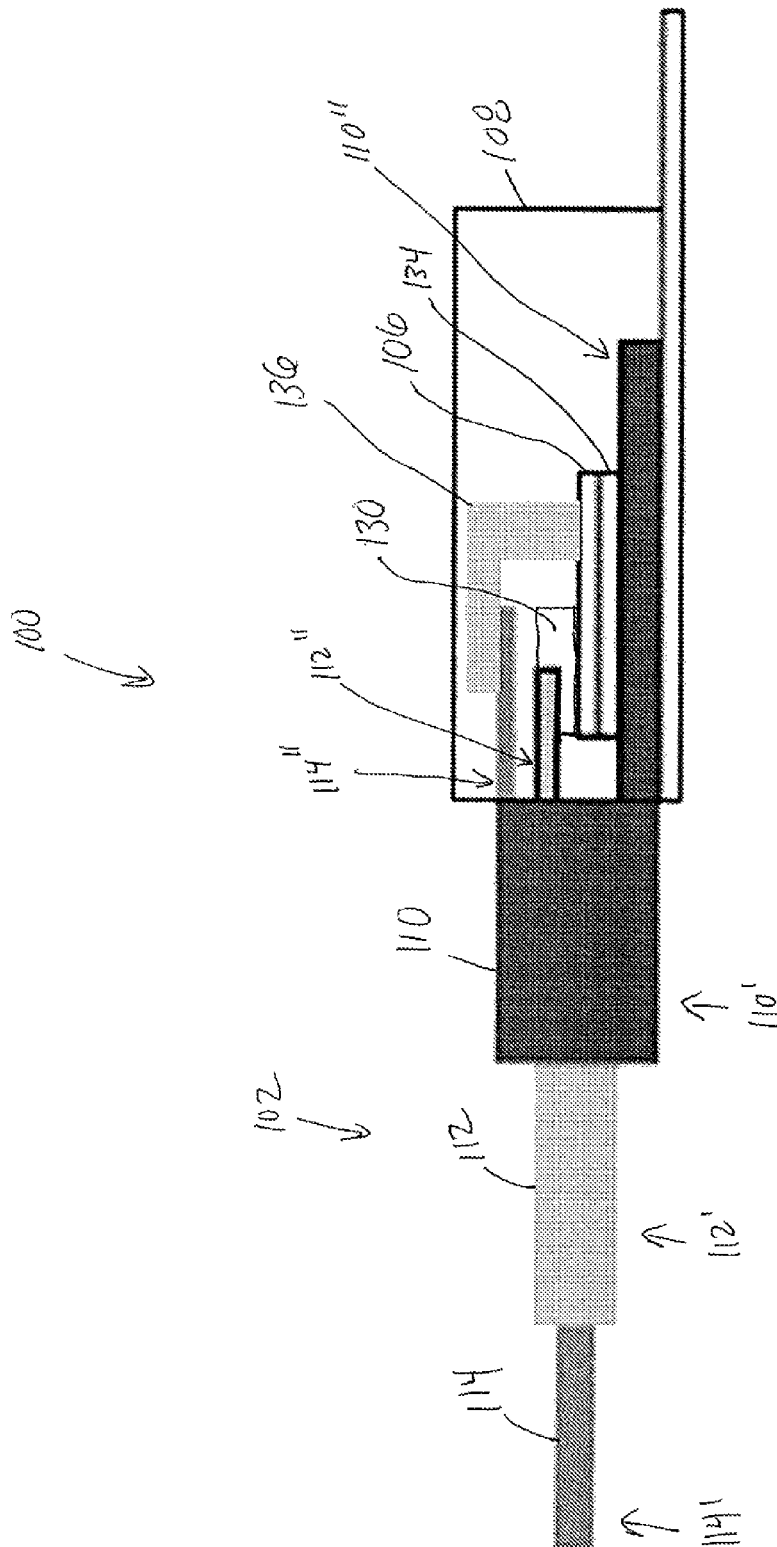


Figure 4

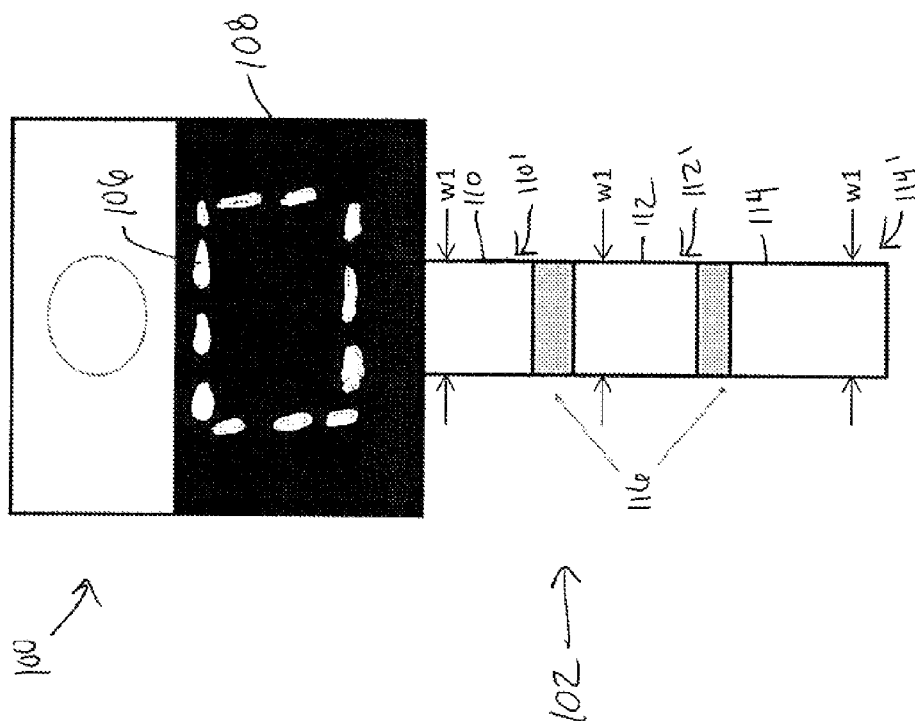


Figure 5A

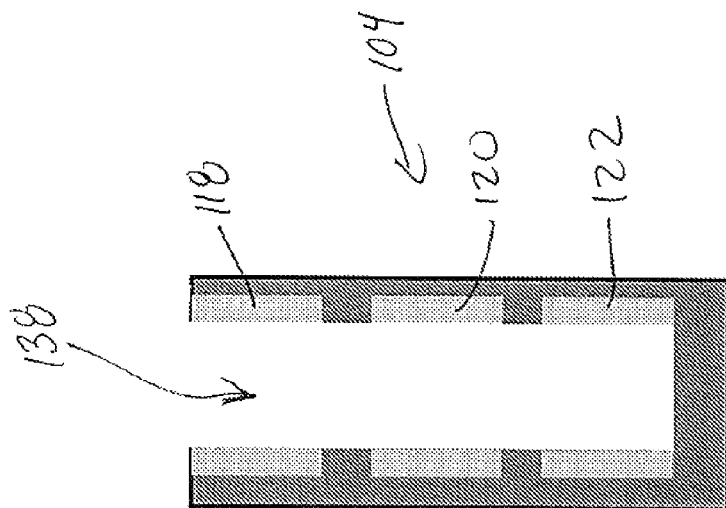


Figure 5B

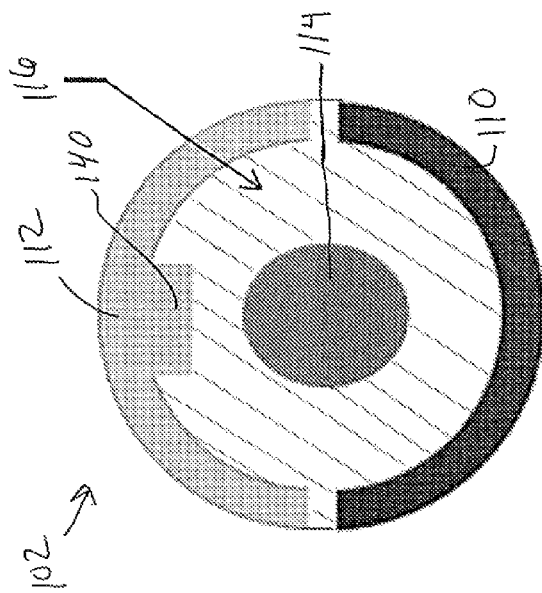


Figure 6B

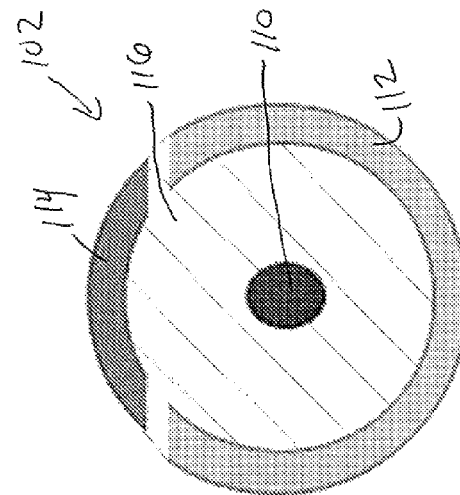


Figure 6C

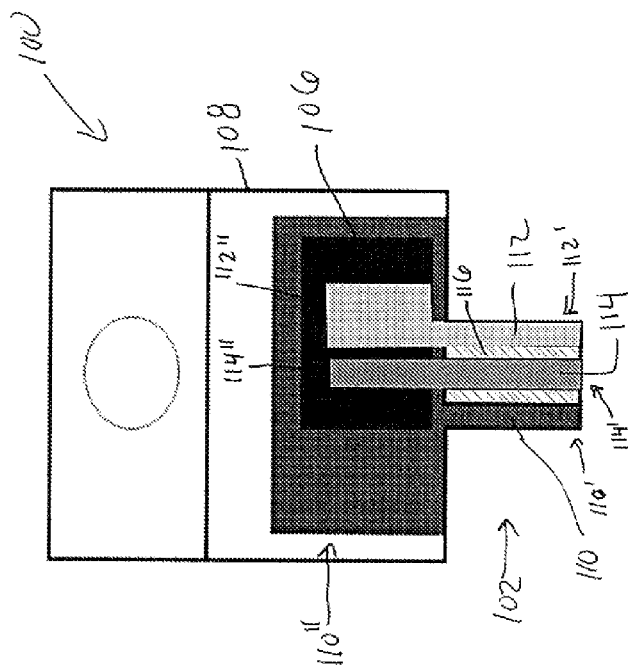


Figure 6A

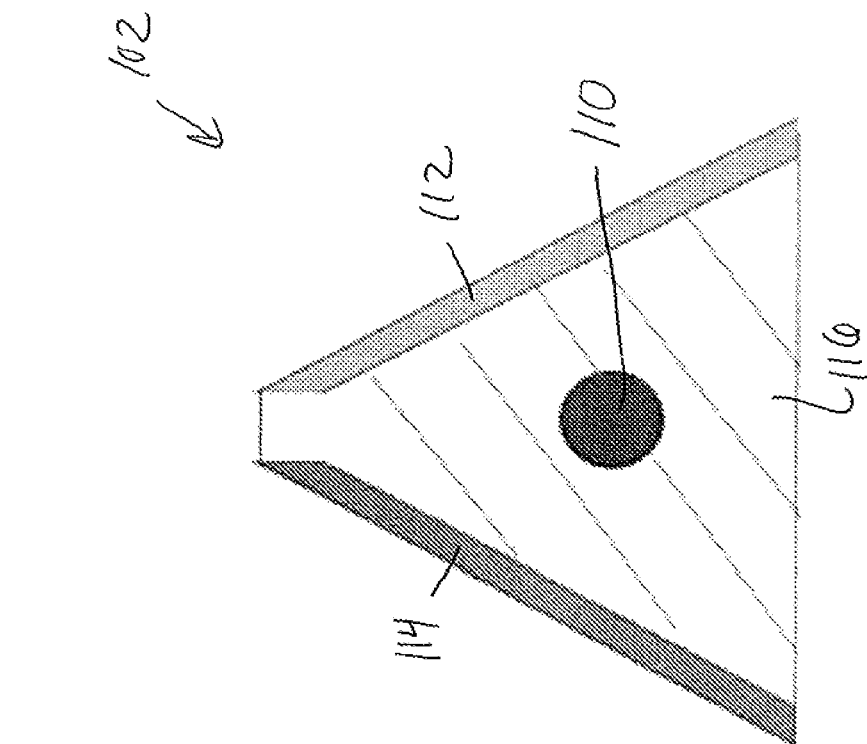


Figure 7

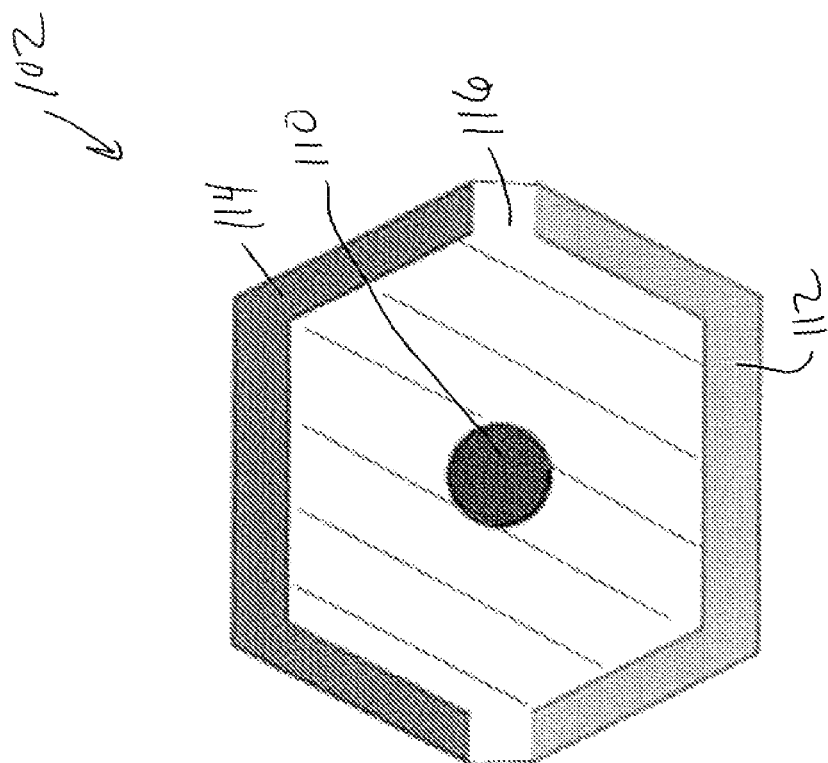


Figure 8

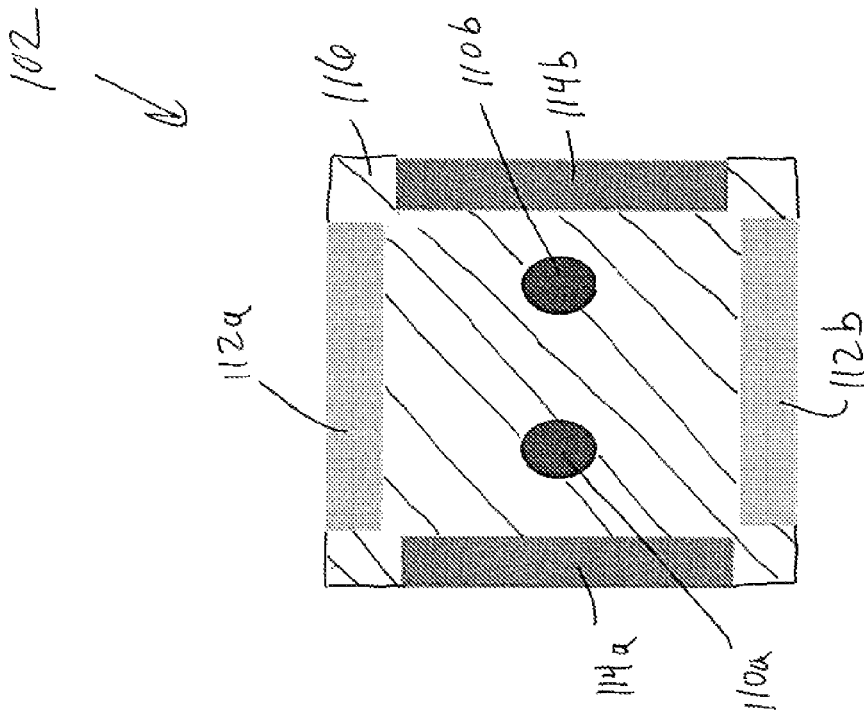


Figure 9

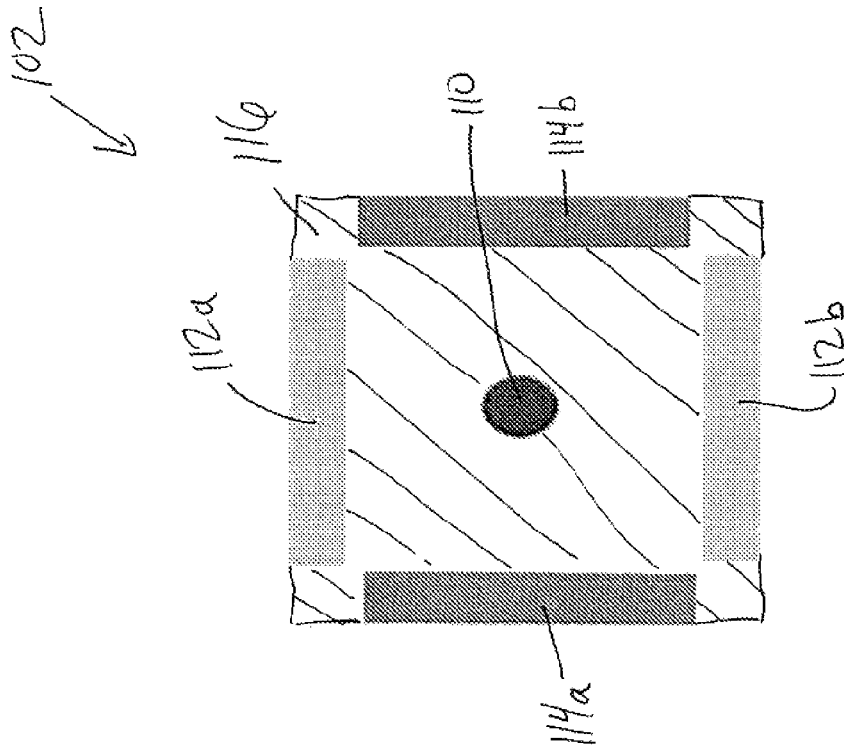


Figure 10

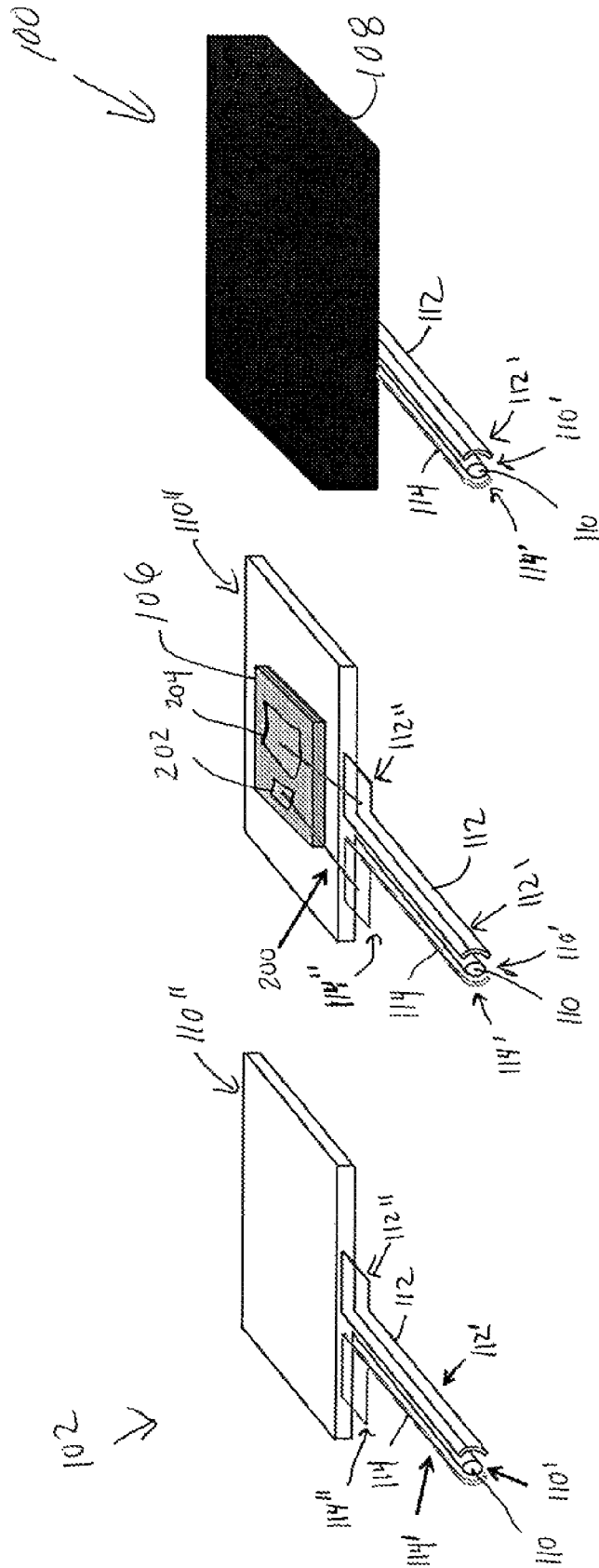


Figure 11C

Figure 11B

Figure 11A

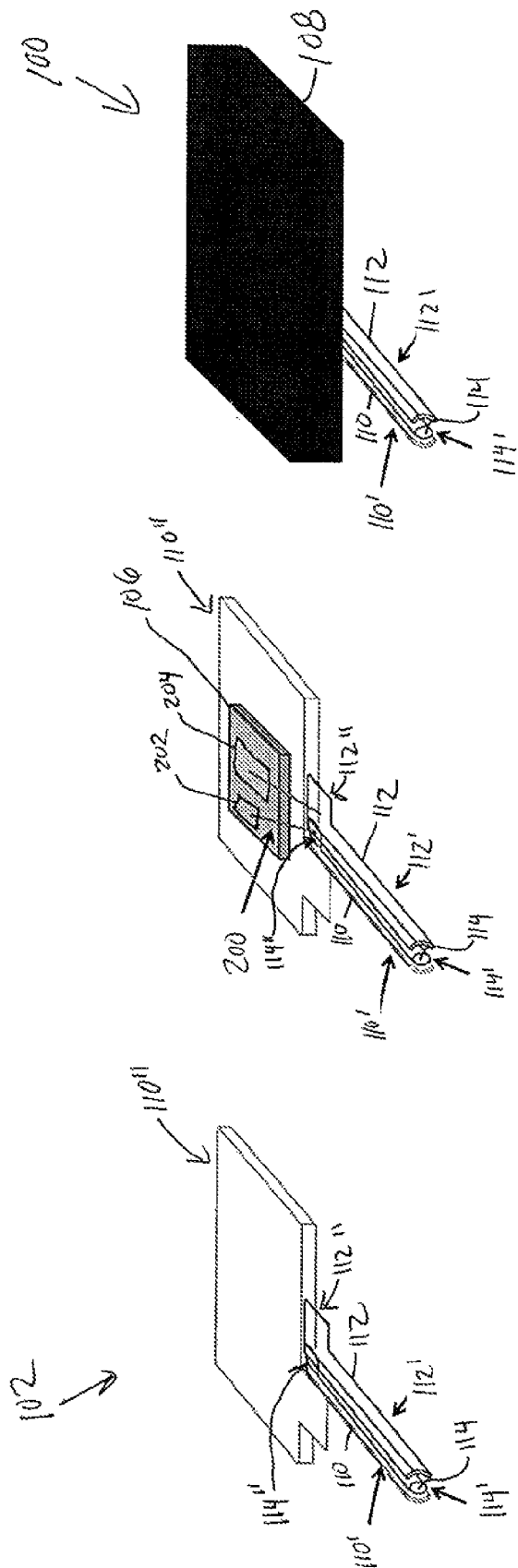


Figure 12C

Figure 12B

Figure 12A

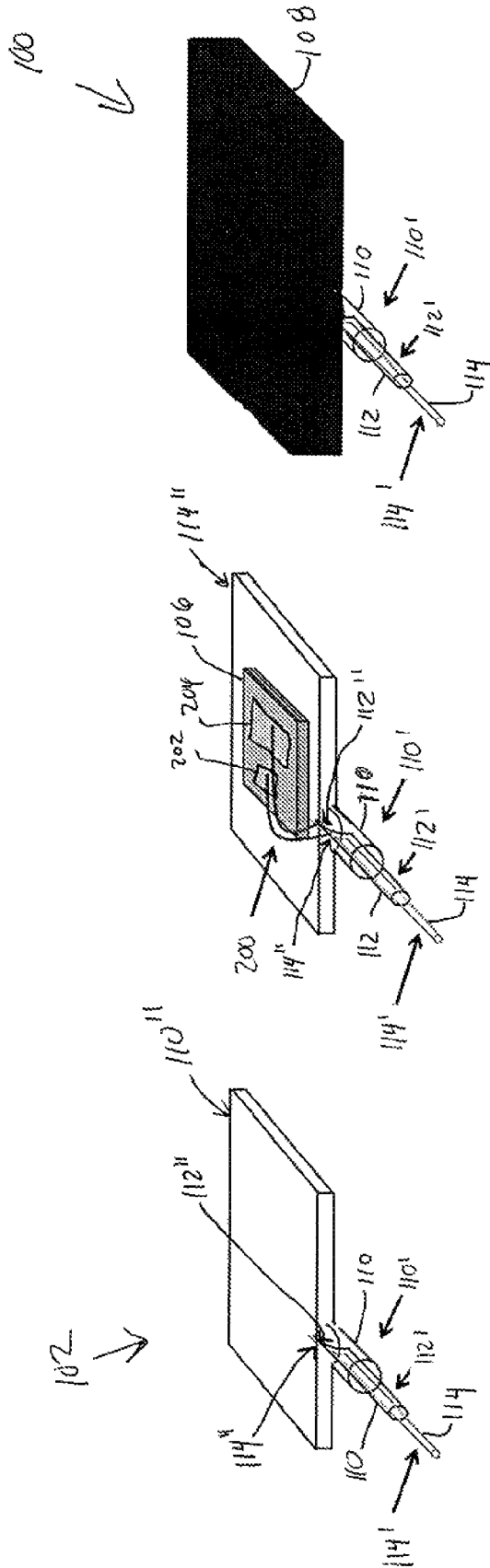


Figure 13C

Figure 13B

Figure 13A

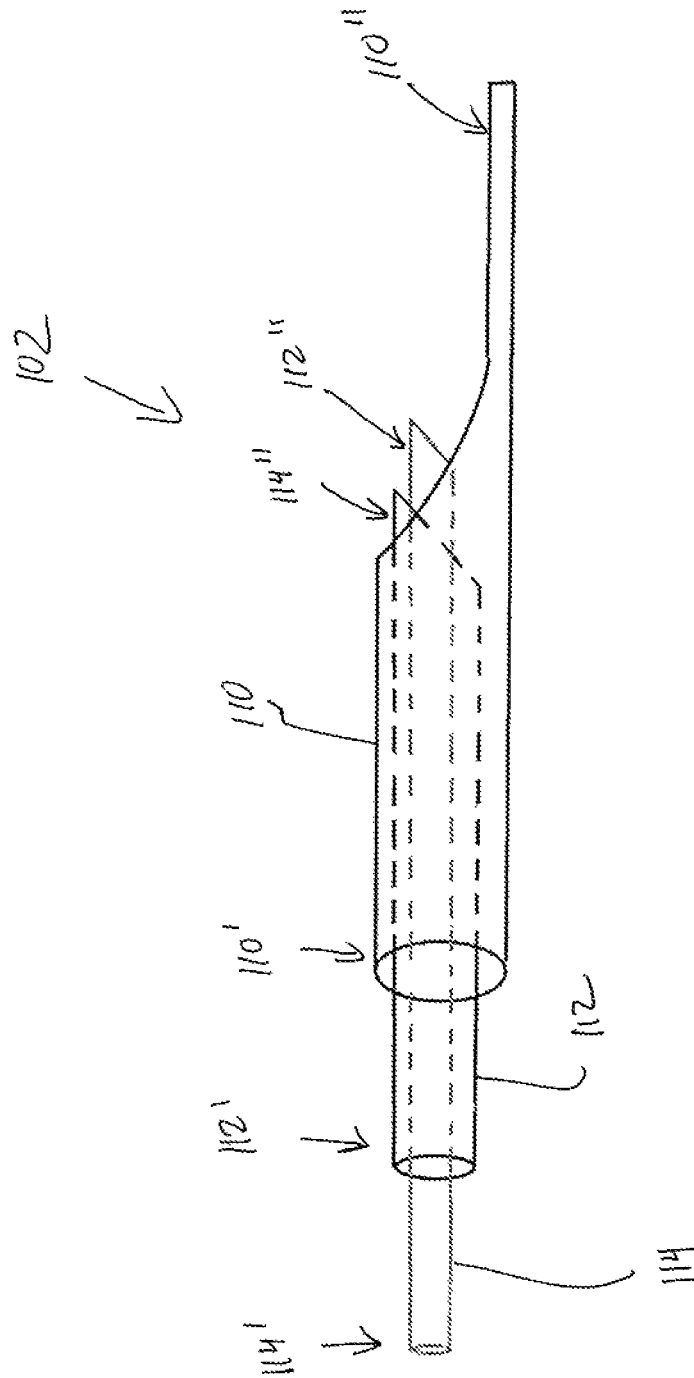


Figure 14

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MOLDED SEMICONDUCTOR PACKAGE WITH PLUGGABLE LEAD

TECHNICAL FIELD

The present application relates to semiconductor packages, in particular the lead configuration for molded semiconductor packages.

BACKGROUND

Power semiconductor transistor packages typically include a power transistor die encapsulated by a molding compound, and three leads protruding from the molding compound. Each lead is electrically connected to a different terminal (e.g. source, gate and drain) of the transistor die, and collectively provide the necessary external electrical connections for the transistor die. Fabricating power semiconductor transistor packages to include a physically separate lead for each terminal of a molded power transistor die increases the size and cost of the package. Also, the leads of a conventional power semiconductor transistor package are typically soldered to another component such as a circuit board. Many hardened applications require solder-less connections, limiting the use of conventional power semiconductor transistor packages to applications in which soldering of the leads is permitted.

SUMMARY

According to an embodiment of a semiconductor package, the semiconductor package comprises a semiconductor die having a plurality of terminals, a molding compound encapsulating the semiconductor die, and a pluggable lead dimensioned for insertion into an external receptacle. The pluggable lead protrudes from the molding compound and provides a separate electrical pathway for more than one terminal of the semiconductor die.

Those skilled in the art will recognize additional features and advantages upon reading the following detailed description, and upon viewing the accompanying drawings.

BRIEF DESCRIPTION OF THE FIGURES

The elements of the drawings are not necessarily to scale relative to each other. Like reference numerals designate corresponding similar parts. The features of the various illustrated embodiments can be combined unless they exclude each other. Embodiments are depicted in the drawings and are detailed in the description which follows.

FIG. 1A illustrates a plan view of an embodiment of a molded semiconductor package having a pluggable lead.

FIG. 1B illustrates a sectional view of a receptacle dimensioned to receive the pluggable lead shown in FIG. 1A.

FIG. 2 illustrates a cross-sectional view of another embodiment of a molded semiconductor package having a pluggable lead.

FIG. 3 illustrates a cross-sectional view of yet another embodiment of a molded semiconductor package having a pluggable lead.

FIG. 4 illustrates a cross-sectional view of still another embodiment of a molded semiconductor package having a pluggable lead.

FIG. 5A illustrates a plan view of an embodiment of a molded semiconductor package having a pluggable lead.

FIG. 5B illustrates a sectional view of a receptacle dimensioned to receive the pluggable lead shown in FIG. 5A.

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FIGS. 6A through 6C illustrate different views of another embodiment of a molded semiconductor package having a pluggable lead.

FIG. 7 illustrates a cross-sectional view of an embodiment of a pluggable lead for a molded semiconductor package.

FIG. 8 illustrates a cross-sectional view of another embodiment of a pluggable lead for a molded semiconductor package.

FIG. 9 illustrates a cross-sectional view of yet another embodiment of a pluggable lead for a molded semiconductor package.

FIG. 10 illustrates a cross-sectional view of an embodiment of a pluggable lead for a molded semiconductor package with more than one semiconductor die.

FIGS. 11A through 11C illustrate different stages of a method of manufacturing a molded semiconductor package having a pluggable lead, according to an embodiment.

FIGS. 12A through 12C illustrate different stages of a method of manufacturing a molded semiconductor package having a pluggable lead, according to another embodiment.

FIGS. 13A through 13C illustrate different stages of a method of manufacturing a molded semiconductor package having a pluggable lead, according to yet another embodiment.

FIG. 14 illustrates a cross-sectional view of the pluggable lead included in the molded semiconductor package manufactured in accordance with the method of FIGS. 13A through 13C.

DETAILED DESCRIPTION

The embodiments described herein provide a molded semiconductor package with a pluggable lead. The pluggable lead is dimensioned for insertion into an external receptacle e.g. on a circuit board. Even though the lead is pluggable, the lead can be soldered if desired but soldering is not required to form a reliable connection with the lead. The pluggable lead provides a separate electrical pathway for more than one terminal of a semiconductor die included in the molded package. For example in the case of a transistor die, the pluggable lead can provide an electrical pathway for the drain, source and gate terminals of the transistor die. In the case of a diode die, the pluggable lead can provide an electrical pathway for the anode and cathode terminals of the transistor die. In general, the lead can have any desired cross-sectional shape and the electrical connections between the lead and the terminals of the molded semiconductor die can be realized in different ways as described later herein in more detail.

FIG. 1, which includes FIGS. 1A and 1B, illustrates an embodiment of a molded semiconductor package **100** that includes a pluggable lead **102** dimensioned for insertion into an external receptacle **104**. FIG. 1A shows a plan view of the pluggable lead **102** and FIG. 1B shows a cross-sectional view of the receptacle **104**. The receptacle **104** is external to the package **100** and can be attached to any desired component such as a circuit board, substrate, card, etc. The receptacle **104** is dimensioned complimentary to the pluggable lead **102**, to securely receive the lead **102**.

In addition to the pluggable lead **102**, the package **100** also includes a semiconductor die **106** having a plurality of terminals (not shown in FIG. 1A) and a molding compound **108** encapsulating the semiconductor die **106**. The semiconductor die **106** is illustrated as a dashed box in FIG. 1A since the molding compound **108** surrounds the die **106**. The pluggable lead **102** protrudes from the molding compound **108** and provides a separate electrical pathway for more than one terminal of the semiconductor die **106**. In one embodiment,

the pluggable lead **102** is the only lead electrically connected to the semiconductor die **106** and provides a separate electrical pathway for each terminal of the die **106**. For example in the case of a transistor die **106**, the pluggable lead **102** can provide separate electrical pathways for the drain, source and gate terminals of the transistor die **106**. In the case of a diode die **106**, the pluggable lead **102** can provide separate electrical pathways for the anode and cathode terminals of the transistor die **106**.

In some cases, the semiconductor die **106** embedded in the molding compound **108** is a vertical transistor die in that current flows through the semiconductor material between the front and back sides of the die **106**. For example, the source and gate terminals of the transistor can be disposed at one side of the die **106** and the drain terminal at the backside of the die **106**. The term 'source terminal' as used herein refers to the source terminal of an FET (field effect transistor) such as a MOSFET (metal oxide semiconductor FET) or GaN HEMT (high electron mobility transistor), or the emitter terminal of a bipolar transistor such as an IGBT (insulated gate bipolar transistor). Likewise, the term 'drain terminal' as used herein refers to the drain terminal of an FET or the collector terminal of a bipolar transistor. More than one semiconductor die **106** can be included in the molded package **100** e.g. in the case of a half-bridge circuit or a GaN HEMT die connected anti-parallel to a separate diode die.

In each case, the electrical pathways of the pluggable lead **102** are formed by electrical conductors **110**, **112**, **114** that are isolated from one another by an electrical insulator **116**. The pluggable lead **102** shown in FIG. 1 comprises a first electrical conductor **110** protruding from the molding compound **108** and electrically connected to a first terminal of the semiconductor die **106**, a second electrical conductor **112** protruding from the molding compound **108** and electrically connected to a second terminal of the semiconductor die **106**, and an electrical insulator **116** isolating the first and second electrical conductors **110**, **112** from one another. The semiconductor die **106** shown in FIG. 1 is a transistor die and the pluggable lead **102** further comprises a third electrical conductor **114** protruding from the molding compound **108** and electrically connected to a third terminal of the semiconductor die **106**.

The electrical conductors **110**, **112**, **114** of the pluggable lead **102** are dimensioned to contact corresponding conductive regions **118**, **120**, **122** of the external receptacle **104** upon insertion of the lead **102** into the receptacle **104**. The points of contact between the electrical conductors **110**, **112**, **114** of the pluggable lead **102** and the corresponding conductive regions **118**, **120**, **122** of the external receptacle **104** can be soldered or solder-less (e.g. press-fit or so-called poka-yoke connection). In one embodiment, the electrical insulator **116** that isolates the electrical conductors **110**, **112**, **114** of the pluggable lead **102** from one another is a molding compound. The same or different type of molding compound can be used to isolate the electrical conductors **110**, **112**, **114** of the pluggable lead **102** as the molding compound **108** that encapsulates the semiconductor die **106**.

Further according to the embodiment shown in FIG. 1, the second electrical conductor **112** of the pluggable lead **102** is partly disposed in and isolated from the first electrical conductor **110** of the lead **102**. The third electrical conductor **114** of the pluggable lead **102** is similarly partly disposed in and isolated from the second electrical conductor **112** of the lead **102**. Also, the second electrical conductor **112** protrudes further outward from the molding compound **108** than the first electrical conductor **110** and the third electrical conductor

114 protrudes further outward from the molding compound **108** than the second electrical conductor **112**.

Each of the electrical conductors **110**, **112**, **114** of the pluggable lead **102** has a distal end **110'**, **112'**, **114'** that remains uncovered by the molding compound **108**. The width (w_1) of the distal end **110'** of the first electrical conductor **110** is greater than the width (w_2) of the distal end **112'** of the second electrical conductor **112** so that the second electrical conductor **112** can fit inside the first electrical conductor **110** as indicated by the more widely spaced set of dashed lines in FIG. 1A. The width (w_2) of the distal end **112'** of the second electrical conductor **112** is greater than the width (w_3) of the distal end **114'** of the third electrical conductor **114** so that the third electrical conductor **114** can fit inside the second electrical conductor **112** as indicated by the more closely spaced set of dashed lines in FIG. 1A. The external receptacle **104** has a shape complimentary to that of the pluggable lead **102**, so that the different width parts of the pluggable lead **102** are received securely within correspondingly sized open regions **124**, **126**, **128** of the receptacle **104**.

FIG. 2 illustrates a cross-sectional view of the molded package **100** of FIG. 1, according to an embodiment. In this embodiment, each electrical conductor **110**, **112**, **114** of the pluggable lead **102** has a curved, edged or shaped distal end **110'**, **112'**, **114'** outside the molding compound **108** and a flat proximal end **110"**, **112"**, **114"** inside the molding compound **108**. The electrical conductors **110**, **112**, **114** can be shaped by stamping or any other suitable process to yield the desired shape within and outside the molding compound **108**. The flat proximal end **110"** of the first electrical conductor **110** is spaced apart from the flat proximal ends **112"**, **114"** of the second and third electrical conductors **112**, **114** and from the semiconductor die **106**. Also according to this embodiment, the flat proximal end **112"** of the second electrical conductor **112** and the flat proximal end **114"** of the third electrical conductor **114** terminate at the same point within the molding compound **108**, with the third electrical conductor **114** being disposed above the second electrical conductor **112** in the molding compound **108**. The flat proximal end **112"** of the second electrical conductor **112** extends over and is attached to a terminal e.g. a source terminal of a transistor die **106** at the top side of the die **106** by solder paste or other electrically conductive attach material **130**. The third electrical conductor **114** is electrically connected to a different terminal e.g. a gate terminal of a transistor die **106** at the top side of the die **106** by one or more bond wires **132**. In the case of a vertical device, the semiconductor die **106** is disposed on the flat proximal end **110"** of the first electrical conductor **110** at the bottom side of the die **106**. A terminal e.g. a drain terminal of a transistor die **106** disposed at the bottom side of the die **106** is attached to the flat proximal end **110"** of the first electrical conductor **110** by solder paste or other electrically conductive attach material **134**. According to this embodiment, the flat proximal end **110"** of the first electrical conductor **110** functions as a die paddle and eliminates the need for a separate die paddle.

FIG. 3 illustrates a cross-sectional view of the molded package **100** of FIG. 1, according to another embodiment. The embodiment shown in FIG. 3 is similar to the embodiment shown in FIG. 2, however, the flat proximal end **114"** of the third electrical conductor **114** of the pluggable lead **102** extends further into the molding compound **108** than the flat proximal end **112"** of the second electrical conductor **112** of the lead **102**.

FIG. 4 illustrates a cross-sectional view of the molded package **100** of FIG. 1, according to yet another embodiment. The embodiment shown in FIG. 4 is similar to the embodi-

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ment shown in FIG. 3, however, the third electrical conductor 114 is electrically connected to the corresponding terminal at the top side of the semiconductor die 106 by a metal clip 136 instead of bond wires 132. The top side of the metal clip 136 i.e. the side facing away from the die 106 can be exposed in some cases. That is, the top side of the metal clip 136 is not necessarily covered by the molding compound 108.

FIG. 5, which includes FIGS. 5A and 5B, illustrates another embodiment of a molded semiconductor package 100 that includes a pluggable lead 102 dimensioned for insertion into an external receptacle 104. FIG. 5A shows a plan view of the lead 102 and FIG. 5B shows a cross-sectional view of the receptacle 104. The pluggable lead 102 and receptacle 104 shown in FIG. 5 are similar to the lead 102 and receptacle 104 shown in FIG. 1, respectively, however the distal end 110', 112', 114' of each electrical conductor 110, 112, 114 of the pluggable lead 102 are of the same width (w1). The receptacle 104 is dimensioned complementarily to the pluggable lead 102, so that the uniform width parts of the pluggable lead 102 are received securely within a uniformly sized open region 138 of the receptacle 104.

FIG. 6, which includes FIGS. 6A through 6C, illustrates yet another embodiment of a molded semiconductor package 100 that includes a pluggable lead 102 dimensioned for insertion into an external receptacle 104. FIG. 6A shows a sectional view of the package 100 along a plane parallel to the top side of the package 100 so that the view of the lead conductors 110, 112, 114 and the semiconductor die 106 is unobstructed by the molding compound 108. FIG. 6B shows a cross-sectional view of the pluggable lead 102 according to a first embodiment and FIG. 6C shows a cross-sectional view of the pluggable lead 102 according to a second embodiment. The pluggable lead 102 has an elongated tubular shape along a length of the lead 102 as shown in FIG. 6A, and a round or circular cross-sectional shape as shown in FIGS. 6B and 6C.

Each electrical conductor 110, 112, 114 of the pluggable lead 102 has a curved distal end 110', 112', 114' protruding from the molding compound 108 as shown in FIGS. 6B and 6C, and a flat proximal end 110'', 112'', 114'' disposed inside the molding compound 108 as shown in FIG. 6A. The electrical conductors 110, 112, 114 can be shaped in this way by stamping or any other suitable process as previously explained herein.

In the case of a vertical device, the semiconductor die 106 is disposed on the flat proximal end 110'' of the first electrical conductor 110 at the bottom side of the die 106. A terminal e.g. a drain terminal of a transistor die 106 disposed at the bottom side of the die 106 is attached to the flat proximal end 110'' of the first electrical conductor 110 by a solder paste or other electrically conductive attach material (not visible in FIG. 6). The flat proximal end 110'' of the first electrical conductor 110 functions as a die paddle according to this embodiment and eliminates the need for a separate die paddle as previously described herein. The second and third electrical conductors 112, 114 are disposed above the semiconductor die 106, within the molding compound 108. According to this embodiment, the second and third electrical conductors 112, 114 are attached to respective terminals at the top side of the semiconductor die 106 by solder paste or other electrically conductive attach material (not visible in FIG. 6). Bond wires or metal clips are not required to complete the electrical connection between the electrical conductors 110, 112, 114 of the pluggable lead 102 and the respective terminals of the semiconductor die 106. Instead, the electrical conductors 110, 112, 114 are attached to the corresponding terminals of the semiconductor die 106.

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According to the embodiment of FIG. 6B, the distal end 110' of the first electrical conductor 110 of the pluggable lead 102 has a curved cross-sectional shape and is disposed at the bottom of the lead 102. The distal end 112' of the second electrical conductor 112 similarly has a curved cross-sectional shape and is disposed at the top of the lead 102. The first and second electrical conductors 110, 112 can be the same or different sizes, and form an enclosure in which the third electrical conductor 114 of the pluggable lead 102 is disposed. The distal end 114' of the third electrical conductor 114 has a circular or oval cross-sectional shape. The electrical conductors 110, 112, 114 are isolated from one another by an electrical insulator 116 such as molding compound or other insulation material/medium. The second electrical conductor 112 can have a tab or protrusion 140 to ensure proper orientation of the lead 102 during insertion into the external receptacle 104.

According to the embodiment of FIG. 6C, the distal end 112' of the second electrical conductor 112 of the pluggable lead 102 has a curved cross-sectional shape and is disposed at the bottom of the lead 102. The distal end 114' of the third electrical conductor 114 also has a curved cross-sectional shape and is disposed at the top of the lead 102. The second electrical conductor 112 has a larger area than the third electrical conductor 114. The first electrical conductor 110 has a circular or oval cross-sectional shape and is disposed in the enclosure formed by the second and third electrical conductors 112, 114. The electrical conductors 110, 112, 114 are isolated from one another by an electrical insulator 116 such as molding compound or other insulation material/medium.

FIG. 7 illustrates a cross-sectional view of another embodiment of the pluggable lead 102. According to this embodiment, the pluggable lead 102 has an octagonal cross-sectional shape. The second electrical conductor 112 of the pluggable lead 102 has an exterior surface with three flat sides at obtuse angles to one another and is disposed at the bottom of the lead 102. The third electrical conductor 114 similarly has an exterior surface with three flat sides at obtuse angles to one another and is disposed at the top of the lead 102. The first electrical conductor 110 has a circular or oval cross-sectional shape and is disposed in an enclosure formed by the second and third electrical conductors 112, 114. The electrical conductors 110, 112, 114 are isolated from one another by an electrical insulator 116 such as molding compound or other insulation material/medium.

FIG. 8 illustrates a cross-sectional view of yet another embodiment of the pluggable lead 102. According to this embodiment, the pluggable lead 102 has a triangular cross-sectional shape. The second and third electrical conductors 112, 114 of the pluggable lead each have a flat exterior surface and the first electrical conductor 110 has a circular or oval cross-sectional shape and is disposed between the second and third electrical conductors 112, 114. The electrical conductors 110, 112, 114 are isolated from one another by an electrical insulator 116 such as molding compound or other insulation material/medium.

FIG. 9 illustrates a cross-sectional view of still another embodiment of the pluggable lead 102. According to this embodiment, the pluggable lead 102 has a square or rectangular cross-sectional shape and includes two second electrical conductors 112a, 112b for electrical connection to a second terminal of a transistor die 106 and two third electrical conductors 114a, 114b for electrical connection to a third terminal of the transistor die 106. The two second electrical conductors 112a, 112b and the two third electrical conductors 114a, 114b form a square or rectangular-shaped enclosure in which the first electrical conductor 110 is disposed. The first

electrical conductor **110** is electrically connected to a first terminal of the transistor die **106**. The electrical conductors **110**, **112a**, **112b**, **114a**, **114b** are isolated from one another by an electrical insulator **116** such as molding compound or other insulation material/medium.

FIG. **10** illustrates a cross-sectional view of a pluggable lead **102** configured for connection to more than one semiconductor die included in a molded package. For example in the case of a half-bridge circuit which includes a high-side transistor die and a low-side transistor die, the pluggable lead **102** can include a first electrical conductor **112a** for electrical connection to the source terminal of the high-side transistor die, a second electrical conductor **112b** for electrical connection to the source terminal of the low-side transistor die, a third electrical conductor **114a** for electrical connection to the gate terminal of the high-side transistor die, and a fourth electrical conductor **114b** for electrical connection to the gate terminal of the low-side transistor die. The first through fourth electrical conductors **112a-114b** form a square or rectangular-shaped enclosure in which fifth and sixth electrical conductors **110a**, **110b** are disposed. The fifth electrical conductor **110a** is electrically connected to the drain terminal of the high-side transistor die and the sixth electrical conductor **110b** is electrically connected to the drain terminal of the low-side transistor die. The first electrical conductor **112a** (electrically connected to the source terminal of the high-side transistor die) or the sixth electrical conductor **110b** (electrically connected to the drain terminal of the low-side transistor die) can be omitted in case the source terminal of the high-side transistor die and the drain terminal of the low-side transistor die are connected within the molded package to form the output of the half-bridge circuit. The electrical conductors **110a**, **110b**, **112a**, **112b**, **114a**, **114b** are isolated from one another by an electrical insulator **116** such as molding compound or other insulation material/medium.

FIGS. **11A** through **11C** illustrate an embodiment of manufacturing a molded semiconductor package **100** having a pluggable lead **102**. In FIG. **11A**, the pluggable lead **102** is provided with three separate electrical conductors **110**, **112**, **114** isolated from one another by an electrical insulator (not shown) such as molding compound or other insulation material/medium. The two outer electrical conductors **112**, **114** form a circular or oval-shaped enclosure in which the inner electrical conductor **110** is disposed. The electrical conductors **110**, **112**, **114** are stamped or otherwise shaped to have a flat proximal end **110"**, **112"**, **114"** to be molded and a curved distal end **110'**, **112'**, **114'** to remain un-molded. As such, the outer surface of each electrical conductor **110**, **112**, **114** of the pluggable lead **102** faces a different direction in a region outside the molding compound **108** than in a region encapsulated by the molding compound **108**.

A vertical transistor die **106** is attached to the flat proximal end **110"** of the inner electrical conductor **110** as shown in FIG. **11B** e.g. by solder paste or other die attach material (out of view). This connection provides a point of electrical contact between the inner electrical conductor **110** of the pluggable lead **102** and a terminal (out of view) disposed at the bottom side of the transistor die **106**. Electrical connections **200** are formed between the outer electrical conductors **112**, **114** of the pluggable lead **102** and corresponding terminals **202**, **204** disposed at the top side of the transistor die **106**. The electrical connections **200** are shown as lines in FIG. **11B**, and can be bond wires, ribbon bond, or metal clips. The transistor die **106**, proximal ends **110"**, **112"**, **114"** of the lead conductors **110**, **112**, **114** and the electrical connections **200** between

the die terminals **202**, **204** and the lead conductors **110**, **112**, **114** are then encapsulated by a molding compound **108** as shown in FIG. **11C**.

FIGS. **12A** through **12C** illustrate another embodiment of manufacturing a molded semiconductor package **100** having a pluggable lead **102**. The embodiment shown in FIGS. **12A** through **12C** is similar to the embodiment shown in FIGS. **11A** through **11C**, however the electrical conductor **110** of the pluggable lead **102** shaped to receive the transistor die **106** is one of the outer conductors **110**, **112** of the lead **102** instead of the inner conductor **114**.

FIGS. **13A** through **13C** illustrate yet another embodiment of manufacturing a molded semiconductor package **100** having a pluggable lead **102**. The embodiment shown in FIGS. **13A** through **13C** is similar to the embodiment shown in FIGS. **11A** through **11C**, however the shape of the pluggable lead **102** corresponds to the embodiment shown in FIG. **1A**. The outermost, widest electrical conductor **110** of the pluggable lead **102** is shaped e.g. by stamping to receive the transistor die **106**.

FIG. **14** shows an enlarged, side perspective view of the pluggable lead **102** illustrated in FIGS. **13A** through **13C**. The proximal end **110"** of the outermost, widest electrical conductor **110** of the pluggable lead **102** i.e. the end to be encapsulated by molding compound **108** can be shaped so that part of the proximal end **112"** of the next widest electrical conductor **112** is uncovered by the outermost, widest electrical conductor **110**. Similarly, the proximal end **112"** of this middle electrical conductor **112** can be shaped so that part of the proximal end **114"** of the innermost, narrowest electrical conductor **114** is uncovered by the middle electrical conductor **112**. Such a construction of the conductor leads **110**, **112**, **114** allows for the necessary electrical connections to be made between the middle and innermost electrical conductors **112**, **114** of the pluggable lead **102** and the corresponding die terminals **202**, **204**.

Spatially relative terms such as "under", "below", "lower", "over", "upper" and the like, are used for ease of description to explain the positioning of one element relative to a second element. These terms are intended to encompass different orientations of the device in addition to different orientations than those depicted in the figures. Further, terms such as "first", "second", and the like, are also used to describe various elements, regions, sections, etc. and are also not intended to be limiting. Like terms refer to like elements throughout the description.

As used herein, the terms "having", "containing", "including", "comprising" and the like are open-ended terms that indicate the presence of stated elements or features, but do not preclude additional elements or features. The articles "a", "an" and "the" are intended to include the plural as well as the singular, unless the context clearly indicates otherwise.

With the above range of variations and applications in mind, it should be understood that the present invention is not limited by the foregoing description, nor is it limited by the accompanying drawings. Instead, the present invention is limited only by the following claims and their legal equivalents.

What is claimed is:

1. A semiconductor package, comprising:
 - a semiconductor die having a plurality of terminals;
 - a molding compound encapsulating the semiconductor die; and
 - a pluggable lead dimensioned for insertion into an external receptacle, the pluggable lead protruding from the mold-

ing compound and providing a separate electrical pathway for more than one terminal of the semiconductor die,

wherein the pluggable lead comprises a first electrical conductor protruding from the molding compound and electrically connected to a first one of the die terminals, a second electrical conductor protruding from the molding compound and electrically connected to a second one of the die terminals, and an electrical insulator isolating the first and second electrical conductors from one another, the first and second electrical conductors dimensioned to contact different regions of the external receptacle upon insertion of the pluggable lead into the receptacle,

wherein the semiconductor die is a transistor die having a drain terminal, a source terminal and a gate terminal, wherein the first electrical conductor of the pluggable lead is electrically connected to the drain terminal of the transistor die and the second electrical conductor of the pluggable lead is electrically connected to the source terminal of the transistor die,

wherein the pluggable lead further comprises a third electrical conductor electrically connected to the gate terminal of the transistor die and isolated from the first and second electrical conductors of the pluggable lead.

2. A semiconductor package, comprising:

an encapsulated transistor die having a first terminal, a second terminal and a third terminal; and

a pluggable lead dimensioned for insertion into an external receptacle, the pluggable lead providing a separate electrical pathway for the terminals of the transistor die,

wherein the pluggable lead comprises a first electrical conductor electrically connected to the first terminal of the transistor die, a second electrical conductor electrically connected to the second terminal of the transistor die, a third electrical conductor electrically connected to the third terminal of the transistor die, and an electrical insulator isolating the electrical conductors from one another, the electrical conductors dimensioned to contact different regions of the external receptacle upon insertion of the pluggable lead into the receptacle.

3. The semiconductor package of claim 2, wherein the electrical insulator is a molding compound.

4. The semiconductor package of claim 2, wherein the first electrical conductor of the pluggable lead is electrically connected to the first terminal of the transistor die by one or more bond wires, and the second electrical conductor of the pluggable lead is electrically connected to the second terminal of the transistor die by one or more additional bond wires.

5. The semiconductor package of claim 2, wherein the first electrical conductor of the pluggable lead is electrically connected to the first terminal of the transistor die by a first metal clip, and the second electrical conductor of the pluggable lead is electrically connected to the second terminal of the transistor die by a second metal clip.

6. The semiconductor package of claim 2, wherein an end of the first electrical conductor of the pluggable lead farthest

from the transistor die has a different cross-sectional shape than an end of the first electrical conductor closest to the transistor die, and wherein an end of the second electrical conductor of the pluggable lead farthest from the transistor die has a different cross-sectional shape than an end of the second electrical conductor closest to the transistor die.

7. The semiconductor package of claim 2, wherein an outer surface of the first electrical conductor of the pluggable lead faces a different direction farther from the transistor die than closer to the transistor die, and wherein an outer surface of the second electrical conductor of the pluggable lead faces a different direction farther from the transistor die than closer to the transistor die.

8. The semiconductor package of claim 2, wherein the first electrical conductor of the pluggable lead is curved farther from the transistor die and flat closer to the transistor die, and wherein the second electrical conductor of the pluggable lead is curved farther from the transistor die and flat closer to the transistor die.

9. The semiconductor package of claim 2, wherein the first electrical conductor of the pluggable lead has a flat region on which the transistor die is disposed at a first side of the transistor die, and the first terminal of the transistor die is disposed at the first side of the transistor die and attached to the flat region of the first electrical conductor.

10. The semiconductor package of claim 9, wherein the second electrical conductor of the pluggable lead has a flat region spaced apart from the flat region of the first electrical conductor and from the transistor die, and the second terminal of the transistor die is disposed at a second side of the transistor die opposite the first side and electrically connected to the flat region of the second electrical conductor.

11. The semiconductor package of claim 10, wherein the second terminal of the transistor die is electrically connected to the flat region of the second electrical conductor by a metal clip or one or more bond wires.

12. The semiconductor package of claim 10, wherein the flat region of the second electrical conductor extends over and is attached to the second die terminal of the transistor die.

13. The semiconductor package of claim 2, wherein the second electrical conductor of the pluggable lead is partly disposed in and isolated from the first electrical conductor of the pluggable lead, and the third electrical conductor of the pluggable lead is partly disposed in and isolated from the second electrical conductor of the pluggable lead.

14. The semiconductor package of claim 13, wherein the second electrical conductor of the pluggable lead protrudes farther away from the transistor die than the first electrical conductor of the pluggable lead, and the third electrical conductor of the pluggable lead protrudes farther away from the transistor die than the second electrical conductor of the pluggable lead.

15. The semiconductor package of claim 14, wherein each of the electrical conductors of the pluggable lead has a distal end adjacent the transistor die, and wherein the distal end of each electrical conductor has the same width.

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